PREHOSPITAL CARE

The prehospital management of chest injuries: a consensus statement. Faculty of Pre-hospital Care, Royal College of Surgeons of Edinburgh

Caroline Lee, Matthew Revell, Keith Porter, Richard Steyn

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This paper provides a guideline for the management of prehospital chest injuries after a consensus meeting held by the Faculty of Prehospital Care, Royal College of Surgeons of Edinburgh, Edinburgh, UK, in January 2005. An overview of the prehospital assessment, diagnosis and interventions for life threatening chest injury are discussed, with the application of skills depending on the training, experience and competence of the individual practitioner.

Chest injuries are significant contributors to death from major trauma and are difficult to assess adequately in the prehospital environment. In addition, the ''classical'' clinical signs of life-threatening chest injury are often absent, leading to a delay in management. There is little published evidence about the prehospital management of chest injuries and more research should be considered. The accompanying guidelines aim to provide a common sense and evidence based approach to the prehospital management of patients with chest injury.

THE PREHOSPITAL APPROACH TO CHEST INJURY MANAGEMENT

- Always use a SAFE approach for any prehospital emergency:
  - Shout/call for help
  - Assess the scene
  - Free from danger?
  - Evaluate the casualty
- Beware of distracting injuries particularly in patients with multiple or dramatic injuries.
- At all times consider whether the casualty requires immediate evacuation to hospital (scoop and run). Chest injuries can cause extremely rapid deterioration and unless the personnel present have the appropriate skills and training to allow necessary intervention, the patient should be transferred to hospital as soon as transport permits. Assessing the mechanism of injury and context (eg, time to hospital and method of transfer) may also guide the practitioner between the balance of staying on scene allowing exposure, assessment and intervention versus rapid transfer.
- Assess airway with cervical spine stabilisation, breathing and circulation. Note that in the presence of catastrophic exsanguinating haemorrhage, rapid external haemorrhage control should be achieved before airway management.[1]
- Recognition of the mechanism of chest injury is essential to guide subsequent assessment and treatment, as severe chest injuries (especially mediastinal injury) can occur in the absence of obvious external injury. The mechanism of injury may also suggest the presence of other life-threatening injuries—for example, to the abdomen or pelvis.
- Mechanism of injury
  - For vehicle collisions note the speed and the rate of deceleration. Were seatbelts, airbags or protective devices used/deployed?
  - For falls record the height and landing surface. Was the fall broken by an object?
  - Is there any deformity of vehicles/ground, etc?
- Appropriate assessment will vary in the skill range from the voluntary first aider to the experienced immediate care doctor. Exposure should be appropriate to the skills available and likely intervention/assessment requirements. Full assessment requires complete exposure to properly assess the left, right, front and back, while avoiding hypothermia or cooling of the casualty. First aiders should be discouraged from unnecessarily exposing patients.

PREHOSPITAL ASSESSMENT

Look (important yet often missed)

- Respiratory rate and pattern. Count for 1 min. Reassess at regular intervals as this will be the first indicator of deterioration of the patient.
- Chest wounds (especially sucking chest wounds) or bruising.
- Movement of the chest wall. Are there any asymmetrical features of chest wall movement? Be vigilant for flail segments with paradoxical or abnormal movements of a section of chest wall. Is there subtle reduced movement of one side of the chest wall with hyperexpansion suggesting a tension pneumothorax?[2] Reduced movement may also be due to pain, pneumothorax or haemothorax.

See end of article for authors' affiliations

Correspondence to: Dr Caroline Lee, Academic Department of Traumatology, Room 28, West Wing, Institute of Research and Development, Birmingham Research Park, Vincent Drive, Birmingham, B15 2SQ, 0121 415 8867, UK; drcarolinelee@hotmail.com

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- Neck wounds, surgical emphysema or neck swelling. The swelling of subcutaneous tissues due to the presence of air within the tissues suggests a pneumothorax is likely to be present. Penetrating neck injuries may be associated with pneumothorax or haemothorax.
- Venous engorgement. This is an inconsistent sign especially if the patient has hypovolaemia and may only be visible if the cervical collar is removed to expose the patients neck.
- Haemoptysis may indicate a tracheobronchial injury or a lung contusion. However, it may simply result from a bleeding facial injury or epistaxis expectorated from the pharynx.

Feel

- Swelling
- Crepitus (crackling in the soft tissues beneath the skin) indicating surgical emphysema.
- Chest wall tenderness or fractures
- Laryngeal crepitus
- Deviation of the trachea indicating tension pneumothorax (a late sign)
- Percussion should be performed if ambient noise allows and skill base permits.
- Examination of the back and armpits is mandatory to prevent missed posterior or lateral chest injuries.

Listen

- Auscultation is often difficult due to location and noise. It will only be of benefit if the environment permits and the practitioner is trained and competent in interpreting the signs on auscultation.
- The lateral chest and anterior armpit should be auscultated to avoid misinterpretation of transmitted sound from the contralateral chest.

Minimum standards of observation

All patients should have recorded:

- Respiratory rate
- Peripheral (radial) pulse rate
- Conscious level—AVPU (Alert, responds to Voice, responds to Pain, Unresponsive)

and in addition if skills permit:

- Pulse oximetry
- Blood pressure
- Conscious level—Glasgow Coma Scale
- ECG monitoring.

The patient should be reassessed every 10 min or whenever there appears to be a change in the patient's clinical status.

INTERVENTIONS

- Oxygen high-flow through non-rebreath mask (15 l/min).
- Cover open wounds of the chest. The Asherman chest seal is recommended, as three-sided dressings are often ineffective.
- Stop external haemorrhage from chest wounds by dressings and direct pressure.
- Manual splinting of flail chests (particularly for the short term in the absence of analgesia). Methods of splinting include direct pressure applied by the hand of the patient or practitioner; positioning the patient laying on the flail segment; or a 500 ml bag of fluid taped over the area of flail.
- Paramedics, doctors and appropriately trained nurses may relieve a tension pneumothorax by needle decompression.
- Rapid sequence induction of anaesthesia is infrequently indicated and should only be performed by appropriately trained and competent doctors.
- If the patient is shocked, or has multiple injuries, then immediate transfer to hospital is indicated with cannulation and intravenous fluid administration en route. Unless transfer times are prolonged, technician crews should not await the arrival of paramedic or medical support before urgent transfer. When prolonged transfer times are expected consideration should be made to the use of helicopter transport or a rendezvous point to meet paramedic or medical support on route to hospital.

Table 2 shows that the interventions provided will depend on the skill level of the prehospital practitioner.

Management of open pneumothorax

Rapid closure of the hole is required using a three sided dressing where other equipment is not available. The optimal treatment is the application of an Asherman chest seal. The skin may need to be shaved or wiped dry of sweat or blood to enable adequate adhesion. If this also fails to secure the device it can be maintained in position with direct pressure. In the case of a large open chest wound, an Opsite dressing can be applied over the surface, with a small hole made in the centre and the aperture of the Asherman chest seal secured over this.

Table 1 Diagnostic features of chest injuries

Features	Tension pneumothorax	Open pneumothorax	Massive haemothorax	Flail chest	Cardiac tamponade	Simple pneumothorax
Penetrating chest wound	Possible	Yes, sucking	Possible	No	Possible	Possible
Reduced chest expansion on affected side	Yes	Possible	Yes	May be reduced inspiratory effort due to pain	No	Possible
Paradoxical movement	No	No	No	Usually	No	No
Surgical emphysema	Possible	Possible	No	No	No	Possible
Percussion note	Very resonant	More resonant	Dull	Normal	Normal	More resonant
Reduced air entry on affected side	Yes	Yes	Yes	May be reduced inspiratory effort due to pain	No	Yes
Neck veins	May be distended	Normal	Flat	Normal	May be distended	Normal
Trachea deviation	Yes, but very late sign	No	No	No	No	No
Hypotension	Yes, as late sign	No	Yes	No	Yes	No
Specific management	Needle decompression	Asherman chest seal or 3 sided dressing	Rapid transfer to definitive care with intravenous fluids on route	Splinting, positioning and intravenous analgesia	Rapid transfer to definitive care	Nil specific in prehospital setting

Table 2 Expected chest injury skills for different levels of provider

Prehospital provider	Expected skills
First aider	Basic airway management Positioning Chest wall splinting Asherman chest seal or 3-sided dressing External haemorrhage control Oxygen administration if trained
Ambulance technician or nurse	As above and Oxygen administration
Paramedic or trained immediate care practitioner (doctor or nurse)	As above and Needle thoracocentesis Intravenous analgesia/fluids
Immediate care specialist (doctor)	As above and Rapid sequence induction Thoracostomy/chest drains Thoracotomy

If the valve of the Asherman chest seal fills with blood it can be milked out of the valve to allow continued effectiveness.

Needle decompression

Tension pneumothorax is a rare prehospital event, particularly in blunt trauma. It is difficult to assess the exact numbers accurately as thoracocentesis is often performed in the absence of a true tension pneumothorax, but recent studies show a prevalence of <6%.[3 4]

Tension pneumothorax is more likely to occur in positive pressure ventilation.[4]

If the patient with multiple trauma is deteriorating, with an unknown cause, specifically look for tension pneumothorax. If localising features are not found consider the presence of bilateral pneumothoraces.

Common features in patients who are awake include universal symptoms of chest pain and respiratory distress, with tachycardia and ipsilateral decreased air entry found in 50–75% of cases. In ventilated patients, the universal findings are rapid onset deterioration with a decrease in oxygen saturations and blood pressure. High ventilation pressures, reduced chest wall movement and air entry are found in about 33% of cases.[5]

Technique of needle decompression

- Avoid thick muscle, breast tissue or areas with surgical emphysema
- The first choice of site is the 2nd intercostal space in the mid-clavicular line. Studies have shown that there is a low accuracy in correct anatomical placement and therefore practitioners should be familiar with the landmarks.[6]
- The standard 14G cannula is 4.5 cm long, and depending on the body mass index of the patient this may not be long enough to decompress all tension pneumothoraces.[7–10]
- The cannula may also fail to decompress the tension pneumothorax due to obstruction by blood, tissue or kinking. Therefore, the cannula should be inserted into the chest attached to a syringe and flushed with 2 ml of air, if there is no obvious air release on insertion.
- Other causes of failure include a localised tension pneumothorax in the patient with pre-existing lung disease,[11]or the presence of a large air leak in which the air will collect in the pleural space quicker than can be drained by the narrow bore of the cannula.[12]
- If the anterior approach fails due to suspected depth of chest wall, then the lateral approach should be attempted in the 5th intercostal space, anterior axillary line if the chest wall appears thinner at this site.
- Consider using a longer needle or a commercial device designed for this purpose.
- If needle decompression fails at both sites, the practitioner is certain of the diagnosis and is appropriately trained and competent: thoracostomy may be performed. After this an intercostal chest drain should be inserted or an Asherman chest seal over the open chest wound.
- Needle decompression should not be used for simple pneumothorax or haemothorax.
- There is considerable risk of iatrogenic pneumothorax if misdiagnosis and decompression is performed. Needle decompression in the absence of a pneumothorax may even create an iatrogenic tension pneumothorax. There is increasing concern regarding the number of needle decompressions being performed without the appropriate clinical indications, leading to significant morbidity and unnecessary interventions for the patient.[13]
- Continuing observation and reassessment is essential by a person who can repeat decompression if necessary: this includes during transfer. If the cannula fails to work and the patient is beginning to retension, repeat needle decompression should be performed adjacent to the initial successful site.

Open thoracostomy

Open thoracostomy is a specialised technique, which should be practised only by appropriately trained practitioners, and should be subject to rigid training and audit systems.[14] Evidence of benefit is poor, with comparison to needle decompression lacking. Simple needle decompression is normally sufficient. Open thoracostomy carries a risk of deterioration due to bleeding or open pneumothorax.

Chest drains

Chest drains should only be inserted in exceptional circumstances by specialised skilled personnel. There are a high rate of complications (25%–30%) including failure, improper placement and iatrogenic lung injury in hospital models.[15 16]

Indications

- Tension pneumothorax—where needle decompression was unsuccessful.
- Massive haemothorax—only in exceptional circumstances where critical respiratory compromise is present from the volume of blood in the chest preventing lung expansion. Exsanguinating haemorrhage from the chest is a potential complication. It is preferable for blood to be conserved in the chest as an isolated tension haemothorax is an unlikely event, and retained blood can potentially be used through a cell saver or other blood salvage system for the patients resuscitation at hospital. In a suspected tension pneumohaemothorax needle decompression should be performed.
- Low altitude aeromedical transfer alone is not an indication for chest drain insertion.
- Consider for remote locations with long transfer times for decompressed tension pneumothoraces and large pneumothoraces.
- Positive pressure ventilation alone is not an absolute indication in the absence of the above indications. However, chest drain insertion should be considered in these patients if there is a significant risk of pneumothorax (eg, signs of surgical emphysema) and it would be difficult to gain access to the chest during transfer.

Technique

- Unless the patient is unconscious the use of local anaesthetic is essential for chest drain insertion, with optional titrated intravenous analgesia.
- Insertion of chest drains should be made using a blunt dissection technique through a reasonable sized access hole after the insertion of a gloved finger and appropriate finger sweep. Normal practise excludes the use of trocars.
- Chest drains should be full size in adults (normally at least 28FG) and directed to the apex.
- Clamping chest drains will only be required occasionally in haemothorax, if the patient is developing increasing levels of shock from rapid bleeding via the chest tube. Constant observation of the patient is then required to detect any deterioration as a result of clamping the tube.
- There is a significant risk of misplacement in transport. The chest drain should be attached to the chest wall securely and practitioners should be vigilant of the position during any transfers or patient movement.

Pericardiocentesis

There is no evidence for prehospital pericardiocentesis. The technique is difficult and associated with cardiac injury. It is unlikely that clotted pericardial blood can be aspirated by a needle, and this technique does not stop continued bleeding from the ventricle into the pericardial sac.

Thoracotomy

This procedure should only be performed by specialist doctors who have the appropriate skills, training and expertise. There is no role for the inexperienced enthusiast to ''have a go''.

Prehospital thoracotomy should only be performed if all the following indications are present:

- Penetrating trauma
- Suspected cardiac tamponade[17]
- Vital signs have been lost in the past 10 min and the hospital is not accessible within the same 10 min
- There is a skilled practitioner to perform the procedure

Contraindications include:

- Cardiac arrest from blunt trauma
- The patient still has a cardiac output
- Definite loss of cardiac output for >10 min.[18–20]

Practitioners should ideally ''scoop and run'' to hospital (with appropriate alert and standby) with the only intervention being establishing a basic airway to allow oxygen delivery and basic life support.[21]

Cannulation

Cannulation should be performed for analgesia or fluids as necessary. Ideally this should be undertaken enroute to prevent extending on scene times. There should be a maximum of two attempts to cannulate. Fluid replacement follows the principles of hypotensive resuscitation to maintain a radial pulse only. High volumes of fluids can be particularly dangerous for the chest injured patient.[22]

Analgesia

Analgesia should be used routinely unless the patient has a time critical injury. The choice of analgesia depends on the skill level of the practitioner and includes:

- Manual splinting or positioning with support from pillows
- Intravenous morphine (consider additional antiemetic)
- Intravenous Ketamine[23]
- Intranasal diamorphine can be considered in children
- Local anaesthetic injection for intercostal nerve blocks[24]
- Entonox should only be used where the above options are unavailable. It is difficult to administer effectively if there is poor inspiratory effort. The use of entonox is associated with decreased oxygen delivery, and the risk of exacerbating a pneumothorax.

Positioning

- If placed on one side this should be good side down as ventilation–perfusion is optimal one third up the chest. If there is a risk of airway contamination (blood in the airway or vomiting) then the injured side of the chest should be positioned down.
- Consider lying the patient on the side of a flail to allow splinting and analgesia.
- If there is an anterior flail chest then manual splinting of the chest may need to be maintained
- Note that the ability to reposition is limited in a moving ambulance
- In an isolated chest injury the ideal position is sitting up. Patients self-splinting using their own chest muscles will be reduced if they lay flat. Avoid long periods positioned supine on a spinal board. If the patient is conscious, with no neck pain and no distracting pain or injuries, patients who wish should be allowed to sit up.
- Unconscious patients with the appropriate mechanism of injury should have full spinal immobilisation.

DISCHARGE FROM SCENE

If the injury is old and the patient has no features suggesting an acute change, it is appropriate to refer patients to their general practitioner or NHS direct (NHS 24 in Scotland).

Discharge from scene (with appropriate advice to attend general practitioner or accident and emergency department) is appropriate if there is:

- No significant mechanism of injury
- No significant comorbidity
- No distracting injuries
- No steering wheel deformation if they are the driver of a vehicle
- No significant marks to the chest
- Normal observations (including respiratory rate)
- Glasgow Coma Score 15
- Rational behaviour
- Not within extremes of age. Children and elderly patients should be transported to hospital for full assessment. The elderly patient may have co-morbidities and limited respiratory reserves that mean even a minor chest injury has significant consequences.

SPECIAL CIRCUMSTANCES

Paediatrics

- Assume time critical. Children can compensate well for injury and evidence of shock is a late sign. Often children can have severe internal chest injuries with minimal or no external evidence of chest injuries. Rib fractures in children signify a significant mechanism of injury and therefore serious injury should be suspected.[25]

- Check for multiple injuries. An isolated chest injury is rare in children.
- Consider non-accidental injury
- Children require smaller chest drains and have smaller intercostal spaces: therefore this procedure requires special expertise. Chest drain insertion is rarely indicated in the prehospital arena.

Blast injury

- Any individual exposed to a blast should be taken to hospital.
- Absence of tympanic damage does not exclude blast lung injury.[26]
- Being shielded from blast fragments does not exclude blast lung injury.
- Prehospital management is supportive.

Embedded objects

- Knives or other objects penetrating the chest should be left in place and not removed.
- The object should be protected from external movement during transfer.
- Movement of a penetrating object with each heartbeat should not be prevented by bandaging or padding.
- Patients who are shocked and having difficulty breathing may become agitated and disorientated. These patients must be observed and handled with care as they may try to dislodge or remove any knives and become a danger to both themselves and any rescuers.

Cardiac arrest

In the event of cardiac arrest after chest trauma the potential reversible causes will be hypoxia, hypovolaemia, tension pneumothorax and cardiac tamponade. Management should be directed to the treatment of these conditions. It should be noted that successful resuscitation is rare.

ALERT AND HANDOVER

All time critical patients with chest injuries, or potentially serious chest injuries, should be prealerted to arrange appropriate trauma team standby at the receiving hospital. This should be done as soon as reasonably possible as appropriate expertise for chest injuries may take longer to mobilise than other standby alerts.

Consider selection of receiving hospital to allow for appropriate expertise (eg, on site cardiothoracic facilities).

The information for the alert should include:

- Mechanism of injury
- Suspected injuries
- Current observations including respiratory rate, pulse and blood pressure
- Treatment given
- Expected time of arrival.

CONCLUSIONS

This consensus statement is based on current evidence and provides a standard of practice: the application of which depends on the training, experience and competence of the individual practitioner. It is intended that this document will be updated in the future to reflect ongoing developments in clinical practice.

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Authors' affiliations

Caroline Lee, SpR Emergency Medicine, Immediate Care Practitioner, Academic Department of Traumatology, West Midlands, UK
Matthew Revell, SpR Trauma and Orthopaedics, West Midlands, UK
Keith Porter, Academic Department of Traumatology, West Midlands, UK
Richard Steyn, Birmingham Heartlands Hospital, Birmingham, UK

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